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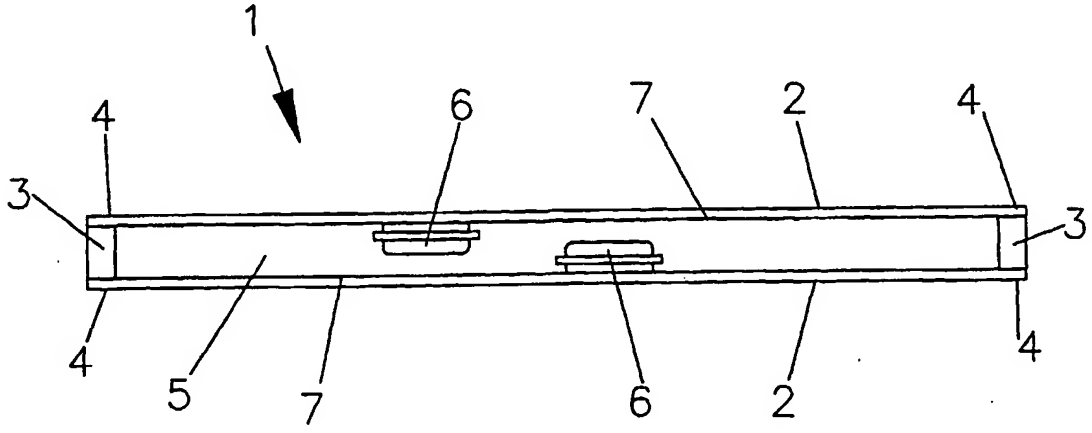
(54) Title: LOUDSPEAKERS



(57) Abstract: A bending wave panel-form loudspeaker comprises a spaced pair of panels defining between them a shallow fluid cavity, a body member surrounding the pair of panels and suspending the panels by their edges, means sealing the cavity and vibration transducers in the fluid cavity and arranged to drive the respective panels, the electrical connections to the transducers being at least partially in antiphase such that the predominant motion of the panels is in phase to provide a degree of dipole radiation property for the loudspeaker, and the cavity being such that the gap between the panels is in the range 2 to 25 mm such that the shallow cavity provides conditions in which fluid coupling dynamics and behaviour is asserted between the pair of panels due to the fluid layer between them.

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TITLE: LOUDSPEAKERS

DESCRIPTION

TECHNICAL FIELD

The invention relates to loudspeakers and more particularly to bending wave panel-form loudspeakers, e.g. resonant bending wave panel speakers as exemplified by the disclosure in WO97/09842 of New Transducers Limited. Loudspeakers as exemplified in WO97/09842 have become known as distributed mode loudspeakers.

BACKGROUND ART

It is known in bending wave panel-form loudspeakers to embed vibration exciting transducers in the loudspeaker panel so that the exciter is hidden and so that the surface of the panel is unobstructed. The provision of an embedded exciter does however complicate the construction of the

loudspeaker in comparison to one having an exciter mounted on the panel surface, and increases the cost of the loudspeaker.

It is an object of the present invention at least to mitigate these problems.

It is known from WO99/67974 to provide a loudspeaker comprising a spaced pair of vibrating diaphragms defining a cavity between them. It is also known from WO98/16409 to provide a vehicle sun visor as a loudspeaker comprising a spaced pair of vibrating panels defining between them a cavity in which piezoelectric transducers for exciting the panels are located. Further more it is known from DE 298,11,727 U1 to provide a loudspeaker comprising a spaced pair of panels defining a cavity in which transducers for exciting the two panels are located.

DISCLOSURE OF INVENTION

According to the invention bending wave panel-form loudspeaker comprises a spaced pair of panels defining between them a shallow fluid cavity, a body member surrounding the pair of panels and suspending the panels by their edges, means sealing the cavity and vibration transducers in the fluid cavity and arranged to drive the respective panels, the electrical connections to the transducers being at least partially in antiphase such that the predominant motion of the panels is in phase to provide a degree of dipole radiation property for the loudspeaker, and the cavity being such that the gap between the panels is in the range 2 to 25 mm such that the shallow cavity

provides conditions in which fluid coupling dynamics and behaviour is asserted between the pair of panels due to the fluid layer between them. In this way the vibration exciters can be surface mounted on the panels, but are hidden from view in the fluid gap. The vibration transducers may be electrodynamic inertial devices.

The body member, which may be in the form of a frame or a shim between the panels, may clamp the panel edges. The body member may form the cavity sealing means.

More than one vibration exciter may be fixed to the inside face of each panel.

The panels may be resonant acoustic radiators, e.g. as disclosed in WO97/09842

From another aspect, the invention is an advertising display comprising a loudspeaker as described above.

BRIEF DESCRIPTION OF DRAWINGS

The invention is diagrammatically illustrated, by way of example, in the accompanying drawings, in which:-

Figure 1 is a cross-sectional side view of a resonant bending wave panel-form loudspeaker of the present invention, and

Figure 2 is a graph of the frequency response of a typical loudspeaker, formed as shown in Figure 1.

BEST MODE FOR CARRYING OUT THE INVENTION

In the drawings, there is shown a distributed mode loudspeaker (1) comprising two resonant bending wave panels

(2) clamped by their edges (4) back to back into a frame (3), and operating as a dipole sound radiator. The two panels and the frame define a sealed shallow cavity (5).

Each of the two (front and back) panels is driven by one or more electrodynamic inertial transducers exciters (6), mounted on the inwardly facing surfaces (7) of the panels so that the exciters (6) are mounted in the cavity (5), and generating distributed mode type bending waves in each of the panels, e.g. as described in WO97/09842. The exciters of the front and rear panel are connected to be electrically out of phase, in order to form a mechanical dipole system, meaning that the mechanical excursion of the front and rear panel is in phase.

The two panels (12) are clamped to the frame (3) around their entire perimeters, to create a small sealed air volume that can be described as a fluid system for a stiff coupling between the front and the pack panel, preventing any unwanted front to back panel interaction caused by an otherwise possible resonance in the enclosure. The fluid coupling between the front and back panel also supports the mechanical dipole excursion due to its high mechanical spring stiffness. In the example of a small panel given below in relation to Figure 2, the cavity depth is 6 mm. It is envisaged that the loudspeakers of the present invention might find application in relation to inexpensive signboards and advertising displays, e.g. point of purchase, or POP, displays in store and supermarkets, the loudspeakers forming an advertising display board with

the additional feature of an audio output to enhance the display appeal. Often such display boards may be relatively large, e.g. around one metre square, and in such a case, the shallow cavity between the panels may be up to 25 mm in depth.

Figure 2 shows the frequency response curve of a panel constructed according to Figure 1. Two identical panels (590 x 495 x 3 mm) are mounted on a rigid spacer frame of 6 mm thickness and form a completely sealed thin closed loudspeaker. Each panel is driven by two 13 mm exciters with a total nominal impedance of 2 ohms. The front and rear exciter configurations are in series connection and electrically out of phase, giving a total nominal impedance of the system of 4 ohm. The sound pressure level measurement shown in Figure 2 is on axis at 0.5 m with 2.83 Vrms input.

The invention thus provides a useful alternative to known embedded bending wave panel-form loudspeakers.

The benefit is an economical two sided bending wave speaker system of desirable thinness which is broadly equivalent to a standard single panel speaker but where the method of excitation is wholly concealed within the speaker assembly. Thus signboards may have information on both sides of an assembly without obstruction. In addition the exciter means is wholly protected from damage, environmental and/or casual.

CLAIMS

1. A bending wave panel-form loudspeaker comprises a spaced pair of panels defining between them a shallow fluid cavity, a body member surrounding the pair of panels and suspending the panels by their edges, means sealing the cavity and vibration transducers in the fluid cavity and arranged to drive the respective panels, the electrical connections to the transducers being at least partially in antiphase such that the predominant motion of the panels is in phase to provide a degree of dipole radiation property for the loudspeaker, and the cavity being such that the gap between the panels is in the range 2 to 25 mm such that the shallow cavity provides conditions in which fluid coupling dynamics and behaviour is asserted between the pair of panels due to the fluid layer between them.

2. A loudspeaker according to claim 1, wherein the body member forms the cavity sealing means.

3. A loudspeaker according to claim 1 or claim 2, comprising means clamping the body member to the panel edges.

4. A loudspeaker according to any preceding claim, wherein the panels are resonant acoustic radiators.

5. A loudspeaker according to any preceding claim, wherein the transducers are electrodynamic inertial devices.

6. An advertising display or signboard consisting of a loudspeaker as claimed in any preceding claim.

Fig 1

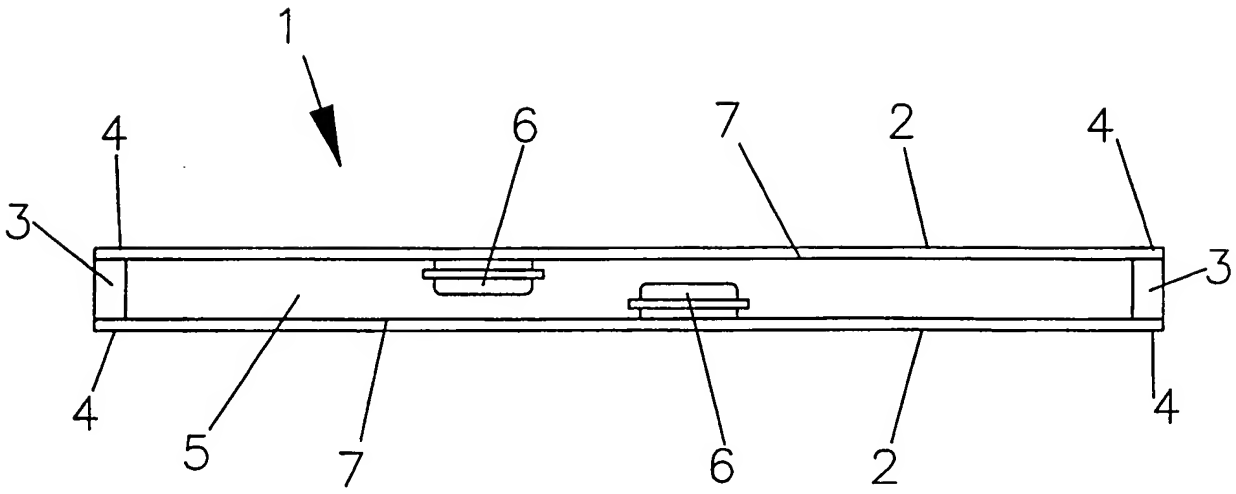
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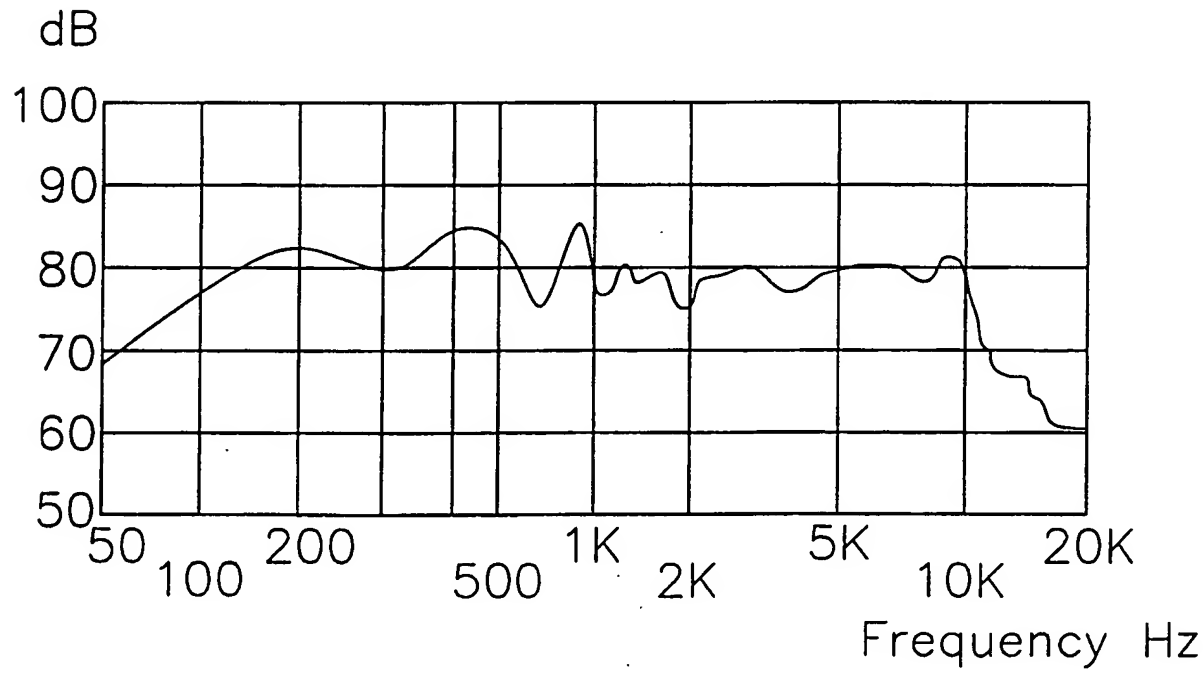
Fig 2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90
80
70
60
50
50
100
200
500
1K
2K
5K
10K
20K
Frequency Hz